Moving Towards a More Aggressive and Comprehensive Model of Care for Children with Ebola

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Ebola is a devastating illness for children, particularly those under 5 years of age.[1-3] Although children are proportionally less affected than adults during outbreaks of Ebola, including in the current West Africa outbreak,[4] it remains a major threat to child health in the affected nations and a neglected area of investigation and discussion.[5] The threat is not only for those infected with Ebola, but for all children in the affected region because of the tremendous impact of this outbreak on national health care systems.[6]

In addition to what appears to be a different immunologic response to Ebola in children,[7] the uniquely challenging bedside care of suspect and infected children plays a significant role in the increased morbidity and mortality in this age group. Little information has been published on efforts to care for children in Ebola treatment units (ETUs). We present a report of our experience caring for children at what was the largest ETU in Port Loko, Sierra Leone, and a discussion of our protocols for caring for children with Ebola, with the hope of stimulating an international dialogue regarding the care of children with this disease.

These protocols represent the culmination of the accumulated experience and knowledge of our ETU health care staff. Although, admittedly, they reflect some shared insights from staff at other ETUs, the majority stem from the published literature with adaptations of standard pediatric therapy. The protocols represent the care we aspired to provide to each child at the time our ETU closed in March 2015 and serve as a starting point for future ETU providers and policymakers for the next Ebola epidemic. Because of resource limitations, a rigorous evidence-based demonstration of efficacy for all of these recommended interventions remains to be done. Thus, the protocols are well rooted in solid, biological rationale and clinical experience but as yet lack ideal empirical support.

Setting

The Maforki ETU was a 106-bed facility opened in October 2014 in a former Red Cross Vocational School (**Figure**; available at www.jpeds.com). The unit was operated by the Sierra Leone Ministry of Health and manned by national staff, international staff through Partners In Health, and members of the Cuban Medical Brigade.[1] The ETU was divided into a holding ward for suspected cases that were pending Ebola virus reverse-transcription polymerase chain reaction (RT-PCR) confirmation of infection and a treatment ward for confirmed Ebola cases.[2] The turnaround time for Ebola RT-PCR and malaria testing was typically 24-72 hours as venous blood samples were sent to an off-site laboratory. Point-of-care glucose and I-STAT (Abbott Laboratories, Abbott Park, Illinois) measurements (including sodium, potassium, chloride, carbon dioxide, anion gap, ionized calcium, glucose, blood urea nitrogen, creatinine, hematocrit, and hemoglobin) became available after the unit was in operation and were used as clinically indicated.

Suspected cases were separated into those with "wet" symptoms of hemorrhage, vomiting, and/or diarrhea, and those who were still "dry" and without such symptoms. Children represented one-tenth to one-third of the patient census at any given time.

Between November 1, 2014, and March 17, 2015, 910 patients were admitted to the Maforki ETU with suspected or laboratory-confirmed Ebola, 908 of whom had ages recorded. Of these 908 admissions, 261 (28.7%) were children under 18 years of age. Eighty-seven (9.6%) were less than 5 years of age, 117 (12.9%) were 5-12 years old, and 57 (6.3%) were 13-17 years of age.

Because Maforki was a holding unit before the treatment center component was added, diagnostic and outcome data are missing for patients in the first months of the unit's operation, making it impossible to determine the specific pediatric case fatality rate (CFR). The published CFR of 75%-80% in children in this and previous epidemics, particularly those under 5 years of age, is consistent with the Maforki ETU experience.[3-7]

Impetus for Change

In December 2014, the ETU at the Hastings Police Training School near Freetown, Sierra Leone, reported an overall

ACT	Artemisinin-combination therapy
CFR	Case fatality rate
ETU	Ebola treatment unit
IO	Intraosseous
IV	Intravenous
PPE	Personal protective equipment
RT-PCR	Reverse-transcription polymerase chain reaction

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CFR of 31.5% among 581 patients, significantly lower than what had been reported previously by other centers.[8] The decrease in mortality was attributed to an aggressive regimen of intravenous (IV) fluids, antibiotics, anti-inflammatory, and nutritional agents. Age-specific mortality rates were not included in their report, so it is impossible to know how well the protocol performed for children. Their protocol influenced the World Health Organization recommendations (modified for Sierra Leone) for the care of patients with Ebola,[2] and served as a foundation for the development of similar aggressive protocols for the care of pediatric and adult patients at Maforki.

Evolution of Pediatric Ebola Treatment Protocols

The Maforki medical protocols assume a range of pediatric experience among practitioners and address the particular challenges in the care of children. The protocols recognize the need for the continuous accompaniment of children to ensure they receive fluids, nutrition, and medications, as well as psychological support. They also stress the critical recognition of chronic malnutrition in children presenting for care and the importance of modified fluid and nutrition protocols for malnourished children.[9]

At Maforki, children were initially integrated with adults in the suspect and confirmed wards of the ETU. Recognizing their need for specialized care, after about 2 months children were separated into their own wards within the suspect and confirmed units. The pediatric wards were stocked with supplies and equipment specific to children's needs (eg, diapers, nutritional products, small-gauge IV needles, toys). Parents and their children suspected of having Ebola were placed together in the pediatric suspect ward. As soon as Ebola was confirmed by RT-PCR in either parent or child, discordant dyads were separated. Similarly, as soon as Ebola was ruled out in 1 person, the 2 were separated and that individual discharged. Mothers were asked to stop breastfeeding on admission to reduce the risk of viral transmission. This required extensive time and reinforcement of alternative feeding methods.

Because parents often were unavailable to attend to their children, additional environmental adaptations were made for the safety of unattended children, who also presented unique challenges to the unit's infection prevention and control protocols (eg, leaving their beds, exploring medical supplies, etc.).[10]

The **Table** summarizes key elements of the medical treatment protocols with full details given in **Appendix 1** (available at www.jpeds.com). Given the severe gastrointestinal fluid losses found in almost all patients with Ebola, significant emphasis was placed on fluid and electrolyte resuscitation. In addition to the liberal use of oral rehydration solution (ideally flavored to improve intake), emphasis was placed on early and aggressive parenteral fluid resuscitation, even among those who appeared well-hydrated initially (except for children confirmed or suspected to have malaria or malnutrition, because of the risk of fluid overload[11]). It was believed that IV access would be easiest to obtain at the time of admission before further fluid losses made finding vascular access difficult. After much consideration and recognition of the risks to both providers and patients, a second IV line was added to the protocol for "wet" patients with active vomiting and/or diarrhea. Pressure bags to increase the rate of fluid administration were also used. In the approximately 10% of children in whom IV access could not be obtained, intraosseous (IO)[12] and occasionally subcutaneous routes (**Appendix 2**; available at www.jpeds.com) were used for fluid resuscitation.[13] The fluid of choice was lactated Ringer solution, ideally supplemented with glucose, potassium, and magnesium, as guided by clinical status and bedside I-STAT monitoring.

Table. Key elements of Maforki pediatric treatment protocols

Initial assessments
Temperature
Weight
Mid-upper arm circumference
Blood pressure
Assessment of hydration status
Oral rehydration solution
IV/IO fluids
Bolus of lactated ringers with 5% dextrose
Reassessments of hydration status and repetition of half boluses
Potassium and magnesium supplementation for those with diarrhea
Nutritional supplementation
F-100 or ready-to-use therapeutic food or BP-100 biscuits
Antimalarials
IV/IM artesunate daily
Complete course with oral artesunate-combination therapy
Antibiotics
IV/IM ceftriaxone daily
Add metronidazole for selected cases
Zinc
Oral zinc daily
Vitamin K
Oral or intramuscular dose on admission
Consideration of additional doses for those with active bleeding
Ondansetron
As needed for nausea and vomiting
Loperamide
As needed for nonbloody diarrhea in confirmed patients with Ebola

Just prior to the unit's closure, a portable bedside ultrasound machine became available. The instrument was used as an aid to IV line placement, for visualizing the inferior vena cava and descending aorta to assess hydration status, to assess the lungs and pleura for signs of effusion or pneumonia or pulmonary edema, and to assess for the presence of ascites as a late sign of fluid overload. Because of its late arrival, use was relatively limited, and it is unclear how much ultrasonography could have ultimately helped overcome the limitations imposed by personal protective equipment (PPE) in performing physical examinations and procedures.

Medications were used to decrease the amount of gastrointestinal losses including antiemetics such as ondansetron (IV and by mouth). Recognizing the controversy around its use, and after careful consideration of risks and benefits,